

cartilaginous plates at the bases, usually dehiscing first between the false septa, rarely indehiscent; seeds sometimes retained within the capsule segments. Seeds compressed, smooth or slightly scalariform, mucilaginous when moistened; endosperm formation of the Helobial type, copious, scanty or absent in the mature seed; embryo straight. Embryo sac development of the Polygonum type, embryo development of the Solanad type. (Including *Cathartolinum* Reichenbach.) LECTOTYPE SPECIES: *Linum usitatissimum* L.; see J. K. SMALL, N. Am. Fl. 25: 67. 1907. (Ancient Latin name for flax and linen.) — FLAX.

A genus of 150–225 species widely distributed in temperate and subtropical regions, particularly in the Northern Hemisphere. Major centers of distribution are the Mediterranean region, the Balkan Mountains, Anatolia, the southwestern United States and Mexico, and the Coastal Plain province of the eastern United States. About 41 species occur in North America. In our area about fifteen species and seven varieties represent three major groups characterized by yellow, white, or blue flowers. The genus has not been examined on a world-wide basis since 1931, and the subgeneric classification is in need of re-evaluation, particularly the relationships between the North American species and those of South America, South Africa, and the Mediterranean region. All species indigenous to our area belong to the “yellow-flowered” group, which is further characterized by small to medium-sized flowers, capitate stigmas, glands on all or the inner sepals, short pedicels, and all or at least the upper leaves alternate. These species are often placed in section CATHARTOLINUM (Reichenb.) Griseb., but are distinct and more closely related to the South American and Old World species referred to section LINASTRUM (Planchon) Reiche. These North American species, along with *Linum catharticum* L., were treated in the genus *Cathartolinum* Reichenb. by Small, who set up eight infrageneric units of undesignated rank, although some have considered them sections. Rogers and Harris have refined this scheme and recognize only five “species complexes” or “groups.”

The *Linum Schiedeanum* complex, characterized by perennial habit, usual presence of stipular glands, persistent and glandular-toothed sepals, staminodia alternating with petals, essentially distinct styles, and capsules separating into ten one-seeded segments, includes fifteen species, with the greatest diversity in east-central Mexico. One member of the complex, *L. arenicola* (Small) Winkler,  $2n = 36$ , distinguished from other species in our area by its separate styles and prominent stipular glands, is endemic to the pine woodlands southwest of Miami, Florida, and on the western Florida Keys. It is closely related to *L. rupestre* (Gray) Engelm. ex Gray,  $2n = 36$ , of Texas, Mexico, and Guatemala, and *L. scabrellum* Planchon,  $2n = 72$ , of central Mexico. *Linum bahamense* Northrop,  $2n = 68$ , known from five islands in the Bahamas, is evidently more closely related to a group of central Mexican species than to *L. arenicola*.

The perennial *Linum virginianum* complex, comprising seven species and distinguished by the capsule separating into 10 one-seeded segments, absence of staminodia, persistent sepals with glandular teeth present only on the inner sepals or absent, distinct styles, and absence of stipular glands, is largely confined to the eastern half of the United States. *Linum intercursum* Bickn.,  $2n = 36$ , with capsules ovoid and pointed at the apices, the septa ciliate, and the false septa clearly incomplete, occurs in the semishade of oak or pine woods along the Coastal Plain from Massachusetts south to the Carolinas and inland to Tennessee, northern Georgia, and Alabama; an isolated population is found in northwestern Indiana. Distinguished by subglobose capsules with rounded apices, nonciliate septa and inner sepal margins with conspicuous stalked glands, *L. medium* (Planchon) Britton var. *texanum* (Planchon) Fern. (*L. Curtissii* Small),  $2n = 36$ , is widespread in the East and also occurs in the Bahamas. The tautonymic variety,  $2n = 72$ , with thicker and wider leaves, is largely confined to the shores of the eastern Great Lakes. Particularly variable in southern Florida, this species needs further study. *Linum virginianum* L.,  $2n = 36$ , has small subglobose capsules with umbilicate apices, sparsely ciliate septa, complete false septa, early dehiscing capsules which leave many specimens without fruit, and sepals glandless or with inconspicuous sessile glands. It is widespread in open woods of the northern and eastern United States, becoming infrequent in the southern Atlantic Coastal Plain. Closely related to the two preceding species, *L. striatum* Walt.,  $2n = 36$ , is distinguished by its predominantly opposite leaves,  $\pm$  elongate paniculate inflorescences, nonciliate septa, and glandless sepals. Ranging from eastern Texas and northern Florida to southeastern Missouri and eastern Massachusetts, with several collections from western Michigan, *L. striatum* is largely restricted to unglaciated regions. Occurring on the Coastal Plain from North Carolina to Louisiana and Florida, *L. floridanum* (Planchon) Trel. has mostly alternate leaves and capsules to 3 mm. long with nonciliate septa. Varietas *floridanum* (*L. macrosepalum* (Small) Winkler, *L. jamaicensis* (Small) Fawcett & Rendle),  $2n = 36$ , has broadly ovoid capsules suffused with purple, and var. *chrysocarpum* C. M. Rogers,  $2n = 36$ , has yellowish ovate capsules. Questionably distinct from the latter variety, known only from the type locality near Mobile, Alabama, and possibly now extinct, *L. macrocarpum* C. M. Rogers is distinguished from *L. floridanum* by the larger capsules (to 3.8 mm. long) with sparsely and inconspicuously ciliate septa. *Linum Westii* C. M. Rogers,  $2n = 36$ , known only from two locations in northern Florida and one in northern Georgia, has predominantly opposite leaves and subglobose capsules with abruptly pointed apices and nonciliate septa.

The *Linum sulcatum* "complex" includes only *L. sulcatum* Riddell,  $2n = 30$ , a common annual species of prairies and fields in the central and eastern United States. It resembles plants of the *L. Schiedeanum* complex in fruit shape and structure, persistent sepals and floral pigmentation, while the thick-walled polyporate pollen and basic chromosome number

of 15 are characteristic of the *L. rigidum* complex. Rogers (1969) suggests that although "it is perhaps unlikely that *L. sulcatum* is on a direct line of evolution connecting the *L. Schiedeanum* and *L. rigidum* complexes, . . . plants resembling *L. sulcatum* may have served as the link between the otherwise very distinct *L. Schiedeanum* and *L. rigidum* complexes." In our area, only *L. sulcatum* has basally united styles and all five sepals glandular-toothed and persistent. Certain collections from the Southeast with dark herbage and racemose inflorescences are sometimes segregated as var. *Harperi* (Small) C. M. Rogers (*L. Harperi* Small).

Typical members of the annual *L. rigidum* complex have capsules separating into five 2-seeded segments, no staminodia, sepals deciduous and at least the inner glandular-toothed, and styles united nearly to the summit. The group is composed of ten species, mostly of the southwestern United States and northern Mexico; two tetraploid populations are endemic to southern Florida, and at least three species occur in the extreme western part of our area. The Florida populations have been considered to be either varieties of *L. rigidum* Pursh,  $2n = 30$ , or a distinct species. Rogers (1968a), drawing on the biosystematic work of Mosquin & Hayley, treated the populations with puberulent or scabrous stems, stipular glands, petals 9–11 mm. long, and found only in the pinelands southwest of Miami as *L. Carteri* Small var. *Carteri*,  $2n = 60$ . The other populations in Dade, Collier, and Monroe counties with  $\pm$  glabrous stems, stipular glands usually lacking, and petals 11.5–17 mm. long were identified as *L. Carteri* var. *Smallii* C. M. Rogers,  $2n = 60$ . *Linum Carteri* is most closely related to *L. rigidum* var. *Berlandieri* (Hooker) Torrey & Gray,  $2n = 30$ , with reddish pigment in the petals and thinner-walled capsules, occurring from southern Texas to eastern Colorado, northern Kansas, and western Arkansas and Louisiana. *Linum alatum* (Small) Winkler (*L. marginatum* Small),  $2n = 30$ , with unique glandular-toothed sepals with scarious margins, is largely confined to southern Texas and adjacent Tamaulipas, with one collection labeled "s.w. La." Another Texan species extending into our area in Louisiana is *L. imbricatum* (Raf.) Shinnars (*L. multicaule* Hooker ex Torrey & Gray),  $2n = 30$ , with fringed glandless sepals and sparsely ciliate upper leaves.

The *Linum neo-mexicanum* complex is similar to the *L. Schiedeanum* complex, but staminodia are absent, and the base chromosome number is 13. None of the three species in this complex from the southwestern United States and northern Mexico approaches our area.

The "white-flowered" group, section CATHARTOLINUM (Reichenb.) Griseb., includes only *Linum catharticum* L.,  $2n = 16$ . This delicate annual has numerous features in common with the "yellow-flowered" group, but the observations of Rogers and Sharsmith indicate that it is not closely related to the flaxes indigenous to North America. This widely distributed European species is established in Nova Scotia and Newfoundland with scattered locations west to Michigan and south to Pennsylvania. No other species in the region has small white flowers and opposite leaves. S. F. Gray

placed *L. catharticum* in his CHAMAELINUM, but the subgeneric category of this taxon is uncertain (cf. Brizicky, Taxon 18: 650. 1969); the name predates Grisebach's sectional combination.

The predominantly European "blue-flowered" group, section LINUM (*Eulinum* Griseb.), with medium to large flowers, linear to capitate stigmas, glandless sepals, long pedicels, all leaves alternate, and stipular glands absent, has only one or two species indigenous to the New World. Widespread in western North America, *L. Lewisii* Pursh,  $2n = 18$ , is sometimes cultivated in the East and has been reported from Cave Mountain, West Virginia (Allard). Plants with sepals less than 5 mm. long are sometimes segregated as *L. pratense* (J. B. S. Norton) Small,  $2n = 18$ . This variable complex has been considered conspecific with the European *L. perenne* L.,  $2n = 18, 36$ , the only consistent difference between them being that *L. Lewisii*, like all the New World species, is homostylous, while *L. perenne* is heterostylous. The latter species is sometimes encountered as a garden escape. Other Old World species introduced to the eastern United States are the red- or pink-flowered *L. grandiflorum* Desf.,  $2n = 16$ , a native of Algeria, and *L. usitatissimum* L. (*L. humile* Mill.),  $2n = 30$ , flax. One of the oldest cultivated plants, flax is grown both for the fibers from which linen is made and for the seeds which yield linseed oil.

Section CLIOCOCCA (Bab.) Planchon contains only the South American *L. selaginoides* Lam., and is perhaps best regarded as a distinct genus. The Old World sections, SYLLINUM Griseb. and DASYLINUM (Planchon) Juz., do not occur in North America.

Rogers (1969) suggests a monophyletic origin for the North American yellow-flowered flaxes with the *L. Schiedeanum* complex, which includes the most primitive members of the group, giving rise to three lines — the *L. virginianum* complex, the *L. neo-mexicanum* complex, and the *L. sulcatum* and *L. rigidum* complexes. East-central Mexico, the center of distribution for the *L. Schiedeanum* complex, is postulated as the region of establishment and diversification of the North American yellow-flowered group. Rogers points out that some South African species are very similar to *L. Schiedeanum*, and preliminary evidence (personal communication) indicates similarities between the South American species and certain Mexican and African species.

A chemotaxonomic study of floral pigments in North American yellow-flowered Linums (Giannasi & Rogers) further emphasized the distinctness of the *L. rigidum* complex, since it possesses the  $\alpha$ -carotenoids leutin and its 5, 6-monoepoxide, while the other species complexes contain only the  $\beta$ -carotenoid violaxanthin. The distribution of the flavonoid pigments supports the presumed relationship between the *L. Schiedeanum* and *L. virginianum* complexes.

All species of *Linum* indigenous to North America are homostylous, while some Old World species are heterostylous. In some heterostylous species, such as *L. perenne*, both the filaments and styles are of different lengths while in others, such as *L. grandiflorum*, only the styles vary in length.

Charles Darwin first recognized that heterostyly is an out-breeding mechanism since the long-styled and short-styled forms are mostly self-sterile but cross-fertile; homostyled flowers are largely self-fertile. (See Baker's interesting paper for a misunderstanding between Darwin and Thomas Meehan, but also involving Asa Gray, about heterostyly and self-compatibility in *L. perenne* and *L. Lewisii*.)

The pollen morphology of *Linum* species is diverse. Aperture types are 3-, 4- or 6-colpate, pantocolpate and pantoporate. The tricolpate grains have been classified on the basis of aperture shape and size and the nature and texture of the nexine covering the colpi. The exine is thin, undulate or thick and bears surface processes that vary in size and shape. These processes may be monomorphic, dimorphic or polymorphic; in a few species the processes are united to form a tegillum which can bear suprategillar processes. The sexine shows a trend from a granular composition to the formation of distinct bacula. Ockendon found in the *L. perenne* group a correlation between aperture number and ploidy level, and between the morphology of the exine processes and the styler condition of the flower. Yermanos & Gill (1967) report that in eight species the pollen was 3-colpate in diploids and 4-colpate in their autotetraploids. To some extent pollen morphological trends follow the subgeneric classification of *Linum*. The thick-walled polyporate pollen of the *L. rigidum* and *L. sulcatum* complexes is evidently the most specialized in the genus.

The North American and European species of *Linum* are well known cytologically, and definite base numbers have been determined in certain sections and species complexes. Polyploidy and aneuploidy have occurred in most groups. Base numbers are: *Linum Schiedeanum* complex, 18, 31, 34; *L. virginianum* complex, 18; *L. neo-mexicanum* complex, 13; *L. sulcatum* and *L. rigidum* complexes, 15; section CATHARTOLINUM, 8; section LINUM, 9, 15; section LINASTRUM (Old World species) 8, 9, 10; section SYLLINUM, 14; section DASYLINUM, 6, 8; and *Linum monogynum* from New Zealand, reported as having  $2n = 84$ . Numerous older undocumented and doubtful counts have been excluded. The hybridization studies of Gill, Gill & Yermanos, and Mosquin & Hayley indicate that chromosomal rearrangements, particularly translocations, have played a major role in the evolution of *Linum* species.

Hybridization in nature is evidently rare, but has been reported in the *Linum rigidum* and *L. virginianum* complexes. Artificial hybrids have been produced in the *L. rigidum* complex and in both the *L. perenne* and *L. usitatissimum* groups of section LINUM.<sup>2</sup> Autotetraploids of the *L. perenne* group ( $2n = 36$ ) can hybridize with *L. usitatissimum* ( $2n = 30$ ). Haploid plants of the latter species have also been produced. There are numerous reports of unsuccessful hybridization attempts involving mostly Old World species.

<sup>2</sup>D. J. Ockendon (personal communication) has obtained a hybrid between *L. Lewisii* and *L. Leonii*, a homostylous member of the European *L. perenne* group, which did not flower.

One *Linum* hybrid cross is often used as an example of the requirement that the hybrid embryo, endosperm, and seed coat be mutually compatible. In the *L. perenne* ♀ × *L. austriacum* ♂ cross, the hybrid embryo develops normally but cannot sprout through the seed coat. If removed, it grows into a vigorous and fertile F<sub>1</sub> hybrid. In the reciprocal cross, the embryo is inhibited and will not develop unless dissected from the seed and placed in a nutrient solution.

## REFERENCES

Most of the voluminous literature on the agricultural aspects of *Linum usitatissimum* has been omitted. Under family references see BOLKHOVSKIKH *et al.*; DAVIS; ERDTMAN, 1964, 1966, 1969; HEGNAUER; HUTCHINSON; KNUTH; LEINFELLNER; NARAYANA; PLANCHON; SAAD, 1961; SHARSMITH; SMALL; and WINKLER.

- ALDABA, V. C. The structure and development of the cell wall in plants. I. Bast fibers of *Boehmeria* and *Linum*. *Am. Jour. Bot.* **14**: 16–24. *pls.* 3–6. 1927. [*L. usitatissimum*, 21, *pl.* 5.]
- ALLARD, H. A. *Linum Lewisii* and *Bouteloua curtipendula* in West Virginia. *Castanea* **3**: 13, 14. 1938. [*L. Lewisii* reported from Cave Mountain, Pendleton County.]
- BAKER, H. G. Charles Darwin and the perennial flax—a controversy and its implications. *Huntia* **2**: 141–161. 1965. [Misunderstanding between Darwin and Thomas Meehan, and involving Asa Gray, caused by the confusion of *L. perenne* and *L. Lewisii* and their different floral biologies; comments on the personalities and allegiances of the three men.]
- BARI, G., & M. B. E. GODWARD. Influence of chromosome size on the radio-sensitivity of *Linum* species. *Canad. Jour. Genet. Cytol.* **11**: 799–802. 1969. [11 spp.]
- & ———. Interspecific crosses in *Linum*. *Euphytica* **19**: 443–446. 1970. [11 spp.; only crosses between *L. usitatissimum*, *L. pallescens*, and *L. africanum* successful; includes chromosome numbers.]
- BARNES, D. K., J. O. CULBERTSON, & J. W. LAMBERT. Inheritance of seed and flower colors in flax. *Agron. Jour.* **52**: 456–459. 1960.
- BROUWER, W., & A. STÄHLIN. *Handbuch der Samenkunde*. Introd. + 656 pp. Frankfurt am Main. 1955. [6 spp. of *Linum*, 356–358.]
- BYRNE, J. M., & C. HEIMSCH. The root apex of *Linum*. *Am. Jour. Bot.* **55**: 1011–1019. 1968. [10 spp. of sects. LINUM and SYLLINUM have two tiers of cortical initials; three North American yellow-flowered spp. have only one.]
- CARTON, A. Études phyllotaxiques sur quelques espèces de *Linum*. *Revue Gén. Bot.* **55**: 137–168. 1948. [*L. usitatissimum*, *L. grandiflorum*, *L. perenne*.]
- CHITTENDEN, R. J. Cytoplasmic inheritance in flax. *Jour. Hered.* **18**: 336–343. 1927. [When gene for “tall” is homozygous in “procumbent” cytoplasm, male-sterile plants result.]
- DANG, K. D. Conséquences de mutilations expérimentales sur la croissance, l’anatomie, l’hydratation et la floraison de quelques espèces de lin. *Bull. Soc. Bot. Suisse* **69**: 346–467. 1959. [*L. austriacum*, *L. angustifolium*, *L. usitatissimum*.]
- DARWIN, C. On the existence of two forms, and on their reciprocal sexual relation, in several species of the genus *Linum*. *Jour. Linn. Soc. Bot.* **7**:

- 69-83. 1864. [Heterostyly and self-incompatibility in *L. grandiflorum*, *L. perenne*, *L. flavum*.]
- DAVIS, P. H. Materials for a Flora of Turkey II: *Linum* Linn. Notes Bot. Gard. Edinburgh 22: 135-161. pls. 6-8. 1957. [Includes discussion of sects. SYLLINUM and DASYLINUM.]
- . Linaceae. Fl. Turkey 2: 425-450. 1967. [Includes 38 indigenous spp. in 4 sects of *Linum*.]
- DILLMAN, A. C. Classification of flax varieties, 1946. U.S. Dep. Agr. Tech. Bull. 1054. 1953.\*
- DODGE, C. R. The present status of flax culture in the United States. Yearb. U.S. Dep. Agr. 1897: 471-486. 1898. [Includes historical data and discussion of *Linum* spp. in cultivation.]
- DORASAMI, L. S., & D. M. GOPINATH. An embryological study of *Linum mysorensense* Hyene. Proc. Indian Acad. Sci. B. 22: 6-9. 1945.
- DOSTÁL, R. Correlative curvatures of the *Linum* hypocotyls and growth regulators. Beitr. Biol. Pflanzen 45: 257-270. 1968. [*L. usitatissimum*; references to earlier papers.]
- DURRANT, A. The environmental induction of heritable change in *Linum*. Heredity 17: 27-61. 1 pl. 1962. [Heritable changes induced in *L. usitatissimum* by fertilizer treatments behave in crosses and grafts like orthodox genetic types; also see EVANS *et al.*]
- EASTMAN, W. The history of the linseed oil industry in the United States. 277 pp. Minneapolis. 1968.
- ESAU, K. Vascular differentiation in the vegetative shoot of *Linum*. I. The procambium. Am. Jour. Bot. 29: 738-747. 1942; II. The first phloem and xylem. *Ibid.* 30: 248-255. 1943; III. The origin of the bast fibers. *Ibid.* 579-586. [*L. perenne*; *L. usitatissimum* included in III.]
- . Plant anatomy. 2nd ed. xx + 767 pp. New York, London, & Sydney. 1965. [*Linum* used to illustrate anatomical features; numerous drawings and plates.]
- EVANS, G. M., A. DURRANT, & H. REES. Associated nuclear changes in the induction of flax genotrophs. Nature 212: 697-699. 1966. [Evidence suggests that DNA changes are associated with the induction of heritable differences; also see DURRANT.]
- EYRE, J. V., & G. SMITH. Some notes on the Linaceae. The cross pollination of flax. Jour. Genet. 5: 189-197. 1916. [Attempts made, mostly unsuccessful, to hybridize eight Old World *Linum* spp.]
- FERNALD, M. L. Midsummer vascular plants of southeastern Virginia. Rhodora 37: 378-413. pls. 384-393; 423-454. pls. 394-405. 1935. [*Linum*, 427-431. pl. 396; *L. medium*, *L. medium* var. *texanum*, *L. floridanum*, *L. intercursum*.]
- FREE, J. B. Insect pollination of crops. xi + 544 pp. London & New York. 1970. [*L. usitatissimum*, 179-182.]
- GIANNASI, D. E., & C. M. ROGERS. Taxonomic significance of floral pigments in *Linum* (Linaceae). Brittonia 22: 163-174. 1970. [North American yellow-flowered spp.]
- GILL, K. S. Evolutionary relationships among *Linum* species. Ph.D. Thesis, Univ. Calif. Riverside. 1966.\* [Diss. Abstr. 27(11): 3727B. 1967.] [41 Old World spp. and 24 interspecific hybrids; mitosis and meiosis; artificial polyploids; fatty acid composition of oils. Cf. GILL & YERMANOS and YERMANOS & GILL.]
- & D. M. YERMANOS. Cytogenetic studies in the genus *Linum*. I. Hybrids

- among taxa with 15 as the haploid chromosome number. *Crop Sci. Madison* 7: 623-627. 1967; II. Hybrids among taxa with nine as the haploid chromosome number. *Ibid.* 627-631.
- GIROLAMI, G. Relation between phyllotaxis and primary vascular organization in *Linum*. *Am. Jour. Bot.* 40: 618-625. 1953. [*L. usitatissimum* 'Punjab'.]
- . Leaf histogenesis in *Linum usitatissimum*. *Ibid.* 41: 264-273. 1954.
- GRISEBACH, A. H. R. *Lineae. Spicillegium florae rumelicae et bithynicae* 1: 115-119. 1843. [*Linum* sections EULINUM, SYLLINUM, CATHARTOLINUM described.]
- HARRIS, B. D. Chromosome numbers and evolution in North American species of *Linum*. *Am. Jour. Bot.* 55: 1197-1204. 1968. [36 taxa.]
- HJELMQVIST, H. The flax weeds and the origin of cultivated flax. *Bot. Not.* 1950: 257-298. 1950. [Mimics of flax, found mostly in flax fields.]
- HOBUSCH, L. Untersuchungen über die Kreuzungsschwierigkeiten bei den Bastarden zwischen *Linum austriacum* und *L. perenne* und deren Nachfolgenerationen. *Zeitschr. Indukt. Abst. Vererbungslehre* 67: 389-434. 1934.
- HOFFMANN, W. *Lein, Linum usitatissimum* L. In: T. ROEMER & W. RUDOLF. *Handbuch der Pflanzenzüchtung*. ed. 2. 5: 264-366. 1961. [Extensive review of literature.]
- HOLDEN, D. J. Factors in dehiscence of the flax fruit. *Bot. Gaz.* 117: 294-309. 1956. [Indehiscent, semidehiscent, and completely dehiscent varieties of *L. usitatissimum*.]
- JUZEP CZUK, S. V. *Linaceae*. In: V. A. KOMAROV. *Fl. URSS* (In Russian.) 14: 84-146. 1949. [See ix-x for classification scheme.]
- KANTOR, T. S. Comparative-embryological research of some cultural and wild species of flax. (In Russian; English summary.) *Trudy Glavn. Bot. Sada Moskva* 6: 170-190. 1959. [*L. usitatissimum*, *L. angustifolium*, *L. perenne*.]
- KAPPERT, H. Erbliche Polyembryonie bei *Linum usitatissimum*. *Biol. Zentralbl.* 53: 276-307. 1933. [Haploid-diploid twins.]
- KHANNA, A. N., & K. B. SINGH. Behavior of pollen-tube growth in some interspecific crosses in the genus *Linum*. *Agra Univ. Jour. Res. Sci.* 5(1): 169-178. *pl.* 3. 1956. [Crosses between *L. usitatissimum* and *L. grandiflorum*, *L. marginale*, *L. angustifolium*, and *L. africanum*.]
- LAIBACH, F. Ectogenesis in plants: Methods and genetic possibilities of propagating embryos otherwise dying in the seed. *Jour. Hered.* 20: 200-208. 1929. (Cf. *Zeitschr. Bot.* 17: 417-459. 1925.) [Hybrids involving six Old World *Linum* spp.]
- LUBBOCK, J. A contribution to our knowledge of seedlings. Vol. 1. vii + 608 pp. London & New York. 1892. [*L. campanulatum*, *L. monogynum*, *L. perenne*, 287-290.]
- MARTIN, A. C. The comparative internal morphology of seeds. *Am. Midl. Nat.* 36: 513-660. 1946. [*Linum*, 624, 625.]
- MIA, A. J. The vegetative shoot apex of *Linum usitatissimum* L. and origin and development of leaf and bud primordia and foliar traces. *Pakistan Jour. Sci. Res.* 7: 159-164. 1955.\*
- MOSQUIN, T., & D. E. HAYLEY. Evolutionary relationships of the southern Florida populations of *Linum rigidum* (Linaceae). *Canad. Jour. Bot.* 45: 1277-1283. 1967. [Hybridization and cytological study between Florida plants ( $2n = 60$ ) and several Great Plain spp. (all  $2n = 30$ ).]
- NESTLER, H. Beiträge zur systematischen Kenntnis der Gattung *Linum*. *Beih. Bot. Centralbl.* 50(2): 497-551. *pls.* 4-7. 1933. [Representatives of sects.



- CATHARTOLINUM, EULINUM, CLIOCOCCA, LINASTRUM, SYLLINUM; also *Hesperolinum*.]
- NIEUWLAND, J. A. Notes on priority of plant names. *Am. Midl. Nat.* 3: 150-158. 1913. [Incorrectly takes *Nezera* Raf. as older than *Cathartolinum* Reichenbach.]
- OCKENDON, D. J. Biosystematic studies in the *Linum perenne* group. *New Phytol.* 67: 787-813. 2 pls. 1968. [Biosystematics of a European complex; scanning electron microscope photomicrographs of pollen.]
- . Taxonomy of the *Linum perenne* group in Europe. *Watsonia* 8: 205-235. 1971.
- OSBORNE, W. P., & W. H. LEWIS. Chromosome numbers of *Linum* from the southern United States and Mexico. *Sida* 1: 63-68. 1962. [14 taxa.]
- PALIWAL, G. S. The development of stomata in *Linum usitatissimum* L. *Curr. Sci. Bangalore* 30: 269-271. 1961. [Syndetocheilic type.]
- PANDEY, K. K. Studies in autotetraploids of linseed (*Linum usitatissimum* L.). I. Growth rate. *Lloydia* 19: 120-128. 1956; II. Morphology and cytogenetics. *Ibid.* 245-268.
- PLESSERS, A. G. The variation in fatty acid composition of the seed of *Linum* species. *Canad. Jour. Genet. Cytol.* 8: 328-335. 1966. [Also chromosome numbers for 7 spp.]
- RAY, C. Cytological studies on the flax genus, *Linum*. *Am. Jour. Bot.* 31: 241-248. 1944. [Chromosomes of 30 spp.; 28 varieties of *L. usitatissimum*.]
- RICKETT, H. W. Wildflowers of the United States. Vol. 2. The Southeastern States. Part 1. x + 322 pp. pls. 1-116. New York. 1966. [*Linum*, 266, 267, pl. 96; 5 spp. illustrated in color.]; Vol. 3. Texas. Part 1. xxii + 275 pp. pls. 1-81. New York. 1969. [*Linum*, 176-178, pls. 51, 52; 7 spp. illustrated in color, including *L. rigidum* and *L. imbricatum*.]
- ROGASH, A. R. Interspecific hybrids in *Linum*. (In Russian; English summary.) *Vestn. Gibridiz.* 2: 84-88. 1941.\*
- ROGERS, C. M. Yellow flowered species of *Linum* in eastern North America. *Brittonia* 15: 97-122. 1963a. [12 spp.; taxonomic treatment; keys, illustrations, maps, exsiccatae.]
- . Studies in *Linum*: *L. imbricatum* and *L. hudsonioides*. *Rhodora* 65: 50-55. 1963b. [Maintains both spp.]
- . *Linum coahuilense*, a new species from northern Mexico. *Ibid.* 66: 278, 279. 1964a. [Later placed in synonymy of *L. flagellare* (Small) Winkler.]
- . Yellow-flowered *Linum* (Linaceae) in Texas. *Sida* 1: 328-336. 1964b. [14 spp.; key, maps.]
- . Yellow-flowered species of *Linum* in Central America and western North America. *Brittonia* 20: 107-135. 1968a. [25 spp.; taxonomic treatment; keys, maps, and exsiccatae.]
- . A reassessment of *Linum rigidum* and *L. Carteri* (Linaceae) in Florida. *Sida* 3: 209, 210. 1968b. [Florida populations of *L. rigidum* complex treated as *L. Carteri*, with 2 vars.]
- . The *Linum bahamense* complex. *Rhodora* 70: 439-441. 1968c.
- . Relationships of the North American species of *Linum* (flax). *Bull. Torrey Bot. Club* 96: 176-190. 1969. [Summary paper on yellow-flowered spp.]
- . Linaceae. In: D. S. CORRELL & M. C. JOHNSTON, Manual of the plants

- of Texas. xv + 1881 pp. Frontisp. + 1 map. Renner, Texas. 1970a. [*Linum*, 897-901.]
- . Some observations on the history of botanical collecting in eastern North America. *Castanea* 35: 78, 79. 1970b. [Number of collections and collectors of *Linum* from 1820 to 1955.]
- . Changing abundance of two species of *Linum* in eastern North America. *Mich. Bot.* 10: 113-116. 1971. [Based on relative number of herbarium collections; *L. virginianum* and *L. medium* var. *texanum*.]
- & B. D. HARRIS. Some new chromosome numbers in *Linum*. *Madroño* 18: 179, 180. 1966. [5 taxa.]
- & ———. Pollen exine deposition: A clue to its control. *Am. Jour. Bot.* 56: 1209-1211. 1969. [In triploid hybrids the spore nucleus evidently does not participate in exine deposition and pattern determination.]
- SAAD, S. I. Phylogenetic development in the apertural mechanisms of *Linum* pollen grains. *Pollen Spores* 3: 33-43. 1961. [Old and New World spp.; drawings and photomicrographs.]
- SIZOVA, M. A. Study of the process of fertilization in interspecific crosses of flax. (In Russian.) *Trudy Prikl. Bot. Genet. Selektiv. Sborn. Puskinskikh Lab.* No. 1: 303-311. 1958.\*
- SOTO, O. The photoperiodic influence on growth and fiber development of flax plants. (In Japanese with English summary.) *Formosan Agr. Rev.* 37: 144-152. 1941.\*
- SOUÈGES, R. Embryogénie des Linacées. Développement de l'embryon chez le *Linum catharticum* L. *Compt. Rend. Acad. Sci. Paris* 178: 1307-1310. 1924. (Cf. *Bull. Soc. Bot. France* 71: 925-938. 1924.)
- TAMMES, T. Die Flachsbilute. *Rec. Trav. Bot. Néerl.* 15: 185-227. 1918.
- . The genetics of the genus *Linum*. *Bibliogr. Genet.* 4: 1-36. 1928. [List of chromosome counts, bibliography.]
- TANNER, F. W. Microbiology of flax retting. *Bot. Gaz.* 74: 174-185. 1922. [*Clostridium amylobacter*.]
- TRELEASE, W. A revision of North American Linaceae. *Trans. Acad. Sci. St. Louis* 5: 7-20. pls. 3, 4. 1887. [*Linum* only.]
- TSCHIRSCH, B. Zur Bildung der cyanogenen Glykoside aus Aminosäuren. *Flora* A. 157: 358-364. 1966.
- UPHOF, J. C. T. Dictionary of economic plants. ed. 2. 591 pp. Lehre. 1968. [*Linum* spp., 314, 315.]
- VAUGHAN, J. G. The structure and utilization of oil seeds. xv + 279 pp. New York. 1970. [*L. usitatissimum*, 140-143.]
- VAZART, J. Infrastructure de l'ovule du lin, *Linum usitatissimum* L. Le complexe antipodial. *Compt. Rend. Acad. Sci. Paris D.* 266: 211-213. 6 pls. 1968.
- WALTERS, S. M., ed. Linaceae. In: T. G. TUTIN, V. H. HEYWOOD, et al., eds., *Fl. Europaea* 2: 206-211. 1968. [*Linum* by D. J. OCKENDON & S. M. WALTERS; *Radiola* by S. M. WALTERS; 36 spp. of *Linum* in 4 sections.]
- XAVIER, K. S. Taxonomic implications of electron and light microscopic studies of *Linum* pollen. 145 pp. 1967. Ph.D. Thesis, Wayne State University, Detroit.\* [Unpublished. Cf. abstr. *Am. Jour. Bot.* 53: 634. 1966; Old and New World spp. examined.]
- & C. M. ROGERS. Pollen morphology as a taxonomic tool in *Linum*. *Rhodora* 65: 137-145. 1963. [Mainly North American yellow-flowered spp.; photomicrographs.]

- YADAVA, T. P., & H. R. KALIA. Taxonomic relationship among some indigenous and exotic species of genus *Linum*. Jour. Res. 5(2, Suppl.): 67-75. 1968. [Hybridization attempts between 15 spp.; specific determinations questionable.]
- & ———. Chromosome numbers and study of meiosis in some species and hybrids of *Linum*. *Ibid.* 76-78. 1968. [*L. usitatissimum*, *L. corymbiferum*, *L. grandiflorum*, *L. Muelleri*.]
- YERMANOS, D. M. Variability in seed oil composition of 43 *Linum* species. Jour. Am. Oil Chem. Soc. 43: 546-549. 1966.
- & K. S. GILL. Induction of polyploidy in *Linum* species. Crop Sci. Madison 7: 423-427. 1967. [Tetraploids induced in mostly Old World species; morphology, cytology, and fertility studied.]
- & ———. Cytology of autotetraploids of *L. usitatissimum* L. and *L. angustifolium* Huds. and their amphidiploid hybrids. Crop Sci. Madison 9: 249, 250. 1969. [Quadrivalent frequencies in hybrids comparable to those of autotetraploids — evidence that the genomes of these species are closely homologous.]

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A REVISION OF THE BORAGINACEAE OF  
WEST PAKISTAN AND KASHMIR \*

S. M. A. KAZMI \*\*

31. *Caccinia* Savi, *Cose Botaniche* 1. t. 1. 1832.

*Anisanthera* Raf. *Fl. Tellur.* 3: 80. 1836.

TYPE SPECIES: *C. glauca* Savi.

Annual (?), biennial, or perennial hispid herbs; leaves alternate; inflorescence terminal; calyx usually divided for 2/3 to 3/4 of its length, never to the base, much enlarged in fruit; corolla tubular to hypocrateriform, tube narrow, long; faucal appendages well developed, large; stamens inserted adjacent to the bases of the faucal appendages, exerted at the apex of the corolla tube, unequal, 4 stamens very small, one very large; style filiform; nutlets 4, usually 1-2 developed, marginate or immarginate,  $\pm$  compressed, smooth.

Species about 6, distributed in southwest and central Asia.

*C. macranthera* (Banks & Soland.) Brand, *Pflanzenr.* IV. 252 (Heft 78): 90. 1921; Riedl in *Rechinger, Fl. Iranica* 48: 227. 1967.

*Borago macranthera* Banks & Soland. in *Russell, Nat. Hist. Aleppo*, ed. 2. 2: 246. 1794.

*Cynoglossum longiflorum* Lehm. *Asperif.* 162. 1818.

*Anisanthera ciliata* Raf. *Fl. Tellur.* 11: 60. 1836.

*Caccinia russellii* Boiss. *Diagn. Pl. Orient. Nov.* I. 2(11): 134. 1849.

TYPE: Aleppo, *Russell s.n.* (BM).

Erect biennial (f. Boissier) to perennial herb. Stems fistulous, fleshy, angular, glabrous, simple or branched above, 20-80 cm. long. Leaves linear, linear-lanceolate, oblong or oblong-lanceolate, obtuse to acute, 7-23 cm. long, 6-40 mm. broad, covered on the upper surface and margins more densely than below with short, stiff, curved bristles, arising from large tuberculate bases, lower surface sometimes glabrous the bristles confined to the midrib. Inflorescence paniculate to thyrsoid-compound, terminal or axillary, short in flower, later elongated in fruit; bracts leaf-like, narrower, and shorter. Pedicels erect, bearing few to many bristles, to 15 mm. long in flower, horizontal to subreflexed, to 25 mm. long in

\* Concluded from volume 52, p. 522.

\*\* The author, formerly a Mercer Research Fellow of the Arnold Arboretum of Harvard University, is presently engaged in studies on the Boraginaceae of North Africa. He will welcome material for identification and will appreciate reprints of papers concerning the family.

fruit. Calyx to 8 mm. long in flower, divided for  $\frac{3}{4}$  of its length, lobes lanceolate, to oblong-lanceolate, acutish, 5–6 mm. long, to 2.5 mm. broad at base, margins of the upper half ciliate, those of the lower half setulose, midrib prominent with few scattered bristles, calyx enlarged to 35 mm. long in fruit, divided to nearly half its length, lobes triangular, to 17 mm. long and 12 mm. broad at base. Corolla tube 9–18 mm. long, lobes linear-oblong, spreading, 5–9 mm. long; faucal appendages puberulous, suborbicular,  $\pm$  1 mm. long. Stamens exerted, anthers unequal, one  $\pm$  5 mm. long, its filament 2 mm. long, the other 4 to 2 mm. long with filaments to 1 mm. long; filaments inserted at the throat of the corolla tube, adjacent to the bases of the faucal appendages. Nutlets grayish to grayish brown, ovoid to suborbicular, 5–11 mm. long, dorsally rugulose, irregularly tuberculate or minutely hirsute, margins dentate, teeth broadly triangular.

DISTRIBUTION OF SPECIES: Syria, Iraq, Iran, Armenia, Caucasus, Turkestan, Pamir Alaj, Afghanistan, West Pakistan.

*Caccinia macranthera* is very variable in its habit, leaf texture, and the position of its inflorescence. The following two varieties may be distinguished.

#### Var. *macranthera*.

*Caccinia macranthera* var. *eu-macranthera* Brand, Pflanzenr. IV. 252 (Heft 78): 90. 1921.

Biennial (teste Boissier). Stems ca. 30 cm. tall, branched near the base, branches divaricate. Leaves oblong-lanceolate, 8–11 cm. long, 10–15 mm. broad. Inflorescence large, paniculate, usually developed to the bases of stems.

DISTRIBUTION OF VARIETY: As that of the species.

In the collections of this species from West Pakistan, I could not find any specimen of this variety. It is reported from east Afghanistan and may be expected in the western parts of our area.

Var. *crassifolia* (Vent.) Brand, Pflanzenr. IV. 252 (Heft 78): 92. 1921;  
Riedl in Rechinger, Fl. Iranica 48: 228. 1967.

*Borago crassifolia* Vent. Descr. Pl. Jard. Cels. 100. t. 100. 1800.

*Caccina glauca* Savi, Cose Botaniche 1, t. 1. 1832; Ledeb. Fl. Rossica 3: 17. 1847; Boiss. Fl. Orient. 4: 277. 1875.

*C. celsii* Boiss. Diagn. Pl. Orient. Nov. I. 2(11): 132. 1849.

*C. crassifolia* (Vent.) C. Koch, Linnaea 22: 647. 1849; M. Pop. Fl. URSS 19: 686. 1953.

*C. crassifolia* (Vent.) C. Koch, f. *normalis* O. Kuntze, Acta Horti Petrop. 10: 212. 1887; Brand, Pflanzenr. IV. 252 (Heft 78): 92. 1921.

*C. crassifolia* (Vent.) C. Koch, f. *linearifolia* O. Kuntze, *ibid.*

*C. crassifolia* (Vent.) C. Koch, f. *persica*, f. *obtusifolia*, and var. *echinata* M. Pop. Acta Horti Bot. Univ. Jurjev. 12: 240, 241. 1911.

TYPE: Persia, inter Hamadan et Tehran, *Bruguère et Oliver, s.n.* (P).

ICON.: Savi, l. c. t. 1. 1832, under *C. glauca*; Vent. l. c. t. 100. 1800, under *Borago crassifolia*.

Perennial. Stems simple to branched, profusely leafy, 30–90 cm. tall. Leaves very variable, linear, lanceolate or oblong, 7–23 cm. long, 6–40 mm. broad. Inflorescence thyrsoïd to paniculate-thyrsoïd, terminal, rarely developed on the lower parts of the stems.

DISTRIBUTION OF VARIETY: as that of species, excluding the western parts of the area.

West Pakistan: GILGIT AGENCY: Northern Hindukush, *Giles s.n.* (K). QUETTA DIST.: Spin Karez, *Crookshank 152* (K); Quetta, *Peddie 318* (K), *Schmid 163* (K), Narai Kotal, *R. R. Stewart 3754* (K); Urak, *R. R. Stewart 28064* (K, RAW). Reported from: Baluchistan, *Stocks s.n.* (K?).

32. *Anchusa* L. Sp. Pl. 133. 1753; Gen. Pl. ed. 5. 64. 1754.

TYPE SPECIES: *A. officinalis* L. (lectotype species).

Perennial, biennial or annual crisp herbs. Calyx 5-fid to 5-partite, lobes more or less elongate in fruit. Corolla infundibuliform to hypocrateriform, tube straight to geniculate, lobes 5, regular to evidently zygomorphic; faucal appendages developed, usually large. Anthers inserted at the same distance from the corolla base on the corolla tube in the regular flowers, at different distances in zygomorphic flowers. Style filiform; stigma capitate to bilobed. Nutlets 4, erect to subhorizontal, areola large, basal to subventral, with fleshy thick rugulose collar.

Species 30–40, centering in the Mediterranean region, but extending through Europe, Africa, and western Asia.

KEY TO THE SPECIES

- a. Biennial to perennial; corolla 13–15 mm. long, tube straight, limb regular. . . . . 1. *A. italica*.  
 a. Annual; corolla 6–7 mm. long, tube geniculate, limb irregular. . . . . 2. *A. ovata*.

1. *A. italica* Retz. Obs. Bot. 1: 12. 1779; Ledeb. Fl. Rossica 3: 119. 1847; Boiss. Fl. Orient. 4: 154. 1875; M. Pop. Fl. URSS 19: 306. 1953; Riedl in Rechinger, Fl. Iranica 48: 233. 1967.

*A. azurea* Mill. Gard. Dict. ed. 8: 9. 1768, *nomen confusum*.

*A. paniculata* Ait. Hort. Kew. 1: 172. 1789.

TYPE: not indicated.

ICON.: Bot. Mag. 48: t. 2917. 1820; Reichenb. Icon. Fl. Germ. 18: t. 106. MCCCVII. fig. 5–8. 1858.

Biennial to perennial herb. Stems usually solitary, branched in the upper

part, 30–60 cm. long, densely covered with white, spreading trichomes of unequal length, to 4 mm. long, arising from tuberculate bases. Basal leaves petiolate, lanceolate, entire, acute, including petioles to 35 cm. long, 6 cm. broad, covered on both surfaces, usually denser on the midrib and veins below, with trichomes more or less like those on the stem; cauline leaves sessile, reduced in size upwards. Inflorescence terminal or axillary, branched, short, scorpioid in flower, elongated in fruit; bracts linear to linear-lanceolate, to 20 mm. long, 2 mm. broad. Pedicels erect, hairy, 1–3 mm. long in flower, elongated to 10 mm. in fruit. Calyx divided to the base, lobes linear to linear-lanceolate, to 10 mm. long and 0.5–1.5 mm. broad in flower, not enlarged in fruit, densely covered with trichomes. Corolla rose-purple when young later turning to pure deep blue, 13–15 mm. long, limb spreading, 7–8 mm. in diameter; faucal appendages large, ciliate. Anthers included  $\pm$  2.2 mm. long; filaments  $\pm$  1.5 mm. long, inserted below the faucal appendages on the corolla tube. Nutlets erect, cylindrical, prominently reticulate-rugose, minutely tuberculate between the wrinkles, ca. 4 mm. long.

**DISTRIBUTION:** Central, southern, and southeastern Europe, North Africa, Turkey, Syria, Caucasus, Iran, Afghanistan, Turkestan, West Pakistan, and Kashmir.

**West Pakistan:** HAZARA DIST.: Dungagali, *Kazmi s.n.* (PES). QUETTA DIST.: Quetta, *Duthie 8686* (BM). RAWALPINDI DIST.: Murree, *R. R. Stewart s.n.* (RAW).

**Kashmir:** Kotli, Hilal Khurd, *A. Rashid 26999* (BM).

Gusuleac (Bull. Fac. Stunte Cernaute 1: 273, 274. 1927) distinguishes three varieties of *Anchusa italica*, viz. var. *italica*, var. *macrocarpa* (Boiss. & Hohen.) Gusuleac, and var. *kurdica* Gusuleac. The specimens collected from West Pakistan and Kashmir belong to the typical variety. The other two varieties differ from the typical one in having trichomes of more or less equal length on the leaf surfaces with the areas between the bases of the trichomes densely pubescent. Var. *macrocarpa* is distributed in Turkish kurdistan, Caucasus, and Iran; whereas var. *kurdica* has its distribution in Cyprus, Syria, Palestine, Iran, and Iraq.

2. *A. ovata* Lehm. Asperif. 1: 222. 1818; Riedl in Rechinger, Flora Iranica 48: 237. 1967.

*Lycopsis orientalis* L. Sp. Pl. 139. 1753.

*L. micrantha* Ledeb. in Pand. Beitr. 65. 1820.

*L. taurica* Stev. Bull. Soc. Nat. Moscou 40: 337. 1857.

*Anchusa orientalis* (L.) Reichenb. Icon. Fl. Germ. 18: 63. 1858, non Linn. 1753.

*Lycopsis arvensis* L. subsp. *orientalis* O. Kuntze, Acta Horti Petrop. 10: 216. 1887.

**TYPE:** Habitat in Caria, *Lehmann, s.n.* (s?).

**ICON.:** Reichenb. Icon. 18: t. 109. fig. 14–16. 1858, under *A. orientalis*.

Annual erect herb. Stems solitary to few, simple or branched, to 50 cm.

long, densely covered with spreading white trichomes of unequal length, to 2 mm. long, arising from tuberculate bases. Basal leaves petiolate, oblong-ovate, roundish at apex, entire to broadly and distantly dentate at margins, attenuated towards the base, including petioles to 12 cm. long and 2 mm. broad, covered on both surfaces with patent or subappressed trichomes with tuberculate bases; cauline leaves subsessile to sessile, sometimes decurrent, lanceolate to broadly ovate, obtuse to subacute, reduced in size upwards. Inflorescence foliate, terminal, short in flower, elongated in fruit. Pedicels slender, hairy, erect, very short in flower, later elongated to 12 mm. in fruit. Calyx divided to the base, lobes linear-lanceolate, acute, densely covered with stiff, long, spreading trichomes with tuberculate bases, 4–5 mm. long, 0.1–1 mm. broad in flower, elongated to 8(–10) mm., sometimes to 2.5 mm. broad at base in fruit. Corolla white to blue, infundibuliform, equalling or slightly exceeding the calyx, 5–6 mm. long, tube geniculate, limb shorter than the tube, to 2 mm. long, irregular, divided 1/2 to 2/3 of its length, lobes unequal; faucal appendages small, papillose. Anthers ovate, obtuse, ca. 0.8 mm. long; filaments very short, inserted 1.5–2 mm. above the corolla base. Nutlets transversely ovate, beaked, dorsally carinate, reticulate-rugose, minutely tuberculate between the wrinkles, areola subventral, large, margins thick, elevated, entire to slightly rugulose.

**DISTRIBUTION:** Bulgaria, Rumania, Turkey, Armenia, Caucasus, Transcaucasus, Iraq, Iran, Afghanistan, West Pakistan, Kashmir, northwestern India, northeast Africa.

**West Pakistan:** CHITRAL STATE: Arkari Gol, west of Tirich Mir, 2900 m., *Stainton 2610* (BM); Mastuj, Baroghil track, Shost, 3000 m., *Stainton 3034* (BM). GILGIT AGENCY: Baltistan, Indus River Valley, *Webster & Nasir 5888* (GH); Skardu, *R. R. Stewart 20426* (GH); Rupal to Gorikot, 2250–2350 m., *R. R. Stewart 18928* (GH); Gurez to Chorwan, Gilgit Road, 2250–2900 m., *R. R. Stewart 19627* (US); above Chorwan, Gilgit Road, 2300–2900 m., *R. R. Stewart 19696* (GH, US). KHYBER AGENCY: Khyber Pass, Afghanistan frontier, 600 m., *R. R. Stewart 9090* (GH). KURRAM AGENCY: Kurram valley, Serjal et Biaut Khel, *Aitchison 507, 569, 858* (GH). SWAT STATE: Mingora, *S. Ali 26098* (BM). Reported from: Swat State, inter Malakand et Barikot, 700 m., *Rechinger 30458* (w); North Waziristan, Khaisota, *J. L. Stewart s.n.* (?).

**Kashmir:** Ladak, Dras, 3000 m., *R. R. Stewart 10020A* (GH); Spitug, 3150 m., *Koelz 2678b* (GH, US); Pitug, *Koelz 6342* (GH, US); Pirpanjal Range, Nil Nag, 1350 m., *R. R. Stewart 23040* (GH); Kishanganga Valley, near Bhagtaur, 2200 m., *R. R. Stewart 17936* (GH); Srinagar, Nishat Bagh, *R. R. Stewart 23070a* (GH); Baramulla, 1500 m., *R. R. Stewart 13901B* (GH). Miscellaneous: Tibet occ., 12000–14000 ped., Herb. Ind. Or. Hook. f. & Thoms., *Thomson s.n.* (GH).

### 33. *Nonea Medicus*, Philos. Bot. 1: 31. 1789.

**TYPE SPECIES:** not indicated.

Annual, biennial or perennial hispid or villous herbs; leaves alternate. Inflorescence lax, racemose, elongate in fruit, foliate. Calyx 5-fid, short-



ly or for 1/2 its length, never divided to the base, enlarged in fruit, tube enclosing the nutlets; corolla campanulate-infundibuliform to subcylindric; faucal appendages distinct, fimbriate, or reduced to fimbriae or sometimes to pilosity only in throat, limb actinomorphic to slightly zygomorphic, lobes 5, imbricate in bud, short to long and spreading; stamens 5, included, anthers oblong, obtuse; ovary deeply 5-lobed, style filiform, stigma short or obscurely bilobed. Nutlets 4, erect with basal areola or more or less transversely ovate with subventral areola, usually rugose, areola of thick, elevated collar, entire to denticulate at margins.

Species about 25, chiefly Mediterranean, distributed in Europe, Asia, and North Africa.

#### KEY TO THE SPECIES

- a. Corolla white.
  - b. Corolla 8–9 mm. long; nutlets 4 mm. long, areola 1–1.5 mm. in diameter, collar 0.5–0.7 mm. high, denticulate at the margins. . . . . 3. *N. edgeworthii*.
  - b. Corolla 6–7 mm. long; nutlets 2.5–3 mm. long, areola 1.5–2 mm. in diameter, collar 1.5–2 mm. high, not denticulate at the margins. . . . . 4. *N. turcomanica*.
- a. Corolla red, violet, blue, or dark brown.
  - c. Faucal appendages comparatively large, long lacerate, fimbria exerted. . . . . 2. *N. kandaharensis*.
  - c. Faucal appendages very minute to lacking.
    - d. Plants annual, corolla 7–12 mm. long, limb short, distinct to indistinct, regular to zygomorphic; areola 1–1.5 mm. in diameter. . . . . 1. *N. caspica*.
    - d. Plants biennial to perennial; corolla 10–20 mm. long, limb long, usually equal half the length of the tube, never zygomorphic; areola 1.5–2 mm. in diameter. . . . . 5. *N. pulla*.

1. *N. caspica* (Willd.) G. Don, Gen. Syst. 4: 336. 1838; Riedl in Rechinger, Fl. Iranica 48: 250. 1967.

*Onosma caspica* Willd. Sp. Pl. 1(2): 775. 1797.

*Lycopsis caspica* Lehm. Asperif. 2: 256. 1818.

*Anchusa picta* M. Bieb. Fl. Taur.-Cauc. 1: 137. 1808.

*Lycopsis picta* (M. Bieb.) Lehm. Asperif. 2: 255. 1818.

*Nonnea picta* (M. Bieb.) Fisch. & C. A. Mey. Index Sem. Hort. Petrop. 43. 1835.

*Nonnea diffusa* Boiss. & Bhuse, Mem. Soc. Nat. Moscou 1860: 152. 1860.

*Nonnea nigericans* "nigrescens" Auct. Fl. Orient. non DC. 1846.

TYPE: In arenosis versus Mare Caspicum, *Willdenow*.

Annual herb. Stems striate, usually many, sometimes solitary, usually ascendent or procumbent, rarely erect, simple, or branched, 5–30 cm. long, covered densely with minute, thin, crisped, spreading trichomes, to 0.5 mm. long, with or without minute tuberculate bases, intermixed densely or sparsely with stout, pungent, spreading trichomes, arising from prom-